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Vacuum System of XAFS Beamline at Shanghai Synchrotron Radiation Facility

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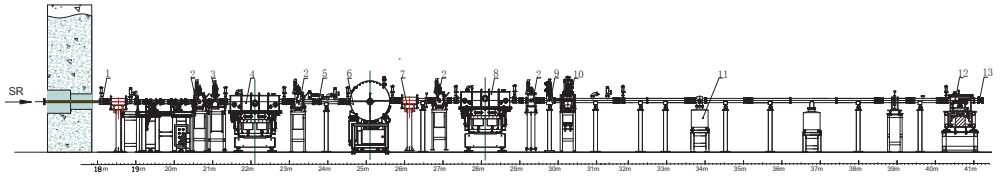
Abstract

A high performance XAFS beamline (BL14W1) has been constructed at Shanghai Synchrotron Radiation Facility (SSRF). In this paper, an overview of the construction and the commission of vacuum system for XAFS beamline will be introduced.

Keywords: Synchrotron, Beamline, Vacuum system

1. Introduction

Shanghai Synchrotron Radiation Facility (SSRF) is a third generation light source with 3.5GeV and 200mA in the storage ring, aimed at producing very brilliant X-ray and soft X-ray beams. SSRF will have 60 beamlines. In the first phase, 7 beamlines have been set up, that 2 for bending magnet (BM) and 5 for insertion device (ID). As one of them, BL14W1 is a general purpose XAFS beamline based on wiggler source. It can provide highly reliable and easy-to-operate system for users on focusing mode and un-focusing mode. A combination of collimating mirror, liquid Nitrogen cooled double crystal monochromator (DCM), focusing mirror and harmonic rejection mirror is chosen for producing focused beam at the experimental station. And in the unfocused mode the collimation and focusing mirror will be removed from the optical path. All these equipments should operate in ultra-high vacuum system even with high heat load from wiggler radiation. Figure 1 shows the Layout for XAFS beamline.



1 Vacuum valve; 2 Fluorescences monitor; 3 C absorber; 4 Collimating mirror; 5 Water-cooled Be window; 6 Liquid-Nitrogen-cooled double crystal monochromator; 7 Lead collimater; 8 Focusing mirror; 9 Water-cooled photon shutter; 10 Safe shutter; 11 Ion pump station; 12 Harmonic rejection mirror; 13 Be window

Fig.1 Layout for XAFS beamline.

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The commission of the BL14W1 is finished in October 2008, and open to the users in April 2009. This report describes the vacuum system for BL14W1, including vacuum system design and the pressure test result.

2. Design of vacuum system for BL14W1

BL14W1 vacuum system is about 24m long in total after frond end and with 100mm diameter vacuum tube except optical equipments. Usually, the pressures in the mirror are less than $\times 10^{-9}$Torr for preventing from carbon contamination on the mirror surface, however, monochromator requiring $\times 10^{-7}$Torr. Fig.2 is a diagram for vacuum system of XAFS beamline. One water-cooled Be window is used to isolate the collimating mirror and the monochromator, otherwise, one differential tube with small section setting in the lead collimater needed to connect the monochromator and the focusing mirror. Thirteen ion pumps, with the whole pumping speed as 4600L/s, distribute along the beamline. Six of them are used for the three mirrors and the monochromator, and five for components nearby mirrors such as the fluorescence and the safe shutter. Nine UHV gate valves are used to separate the beamline to ten individual parts for ease pretreatment offline and commission online, and ten cold cathode gauges set for them.

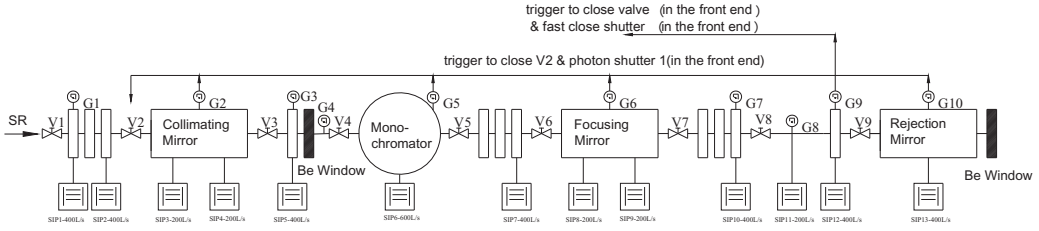

Fig.2 Vacuum system for XAFS beamline.

A vacuum protection interlock is set up for each beamline, which including a slow interlock and a quick interlock system. In BL14W four gaugesG2, G5, G6, and G10, combined with valve 2 (V2), provide a slow interlock. When gauge reading is larger than $\mathbf{5\times 10^{-7}}$Torr, the interlock system will give a alarm; and as reading to $\mathbf{5\times 10^{-5}}$Torr, the system will close valve 2 and photon shutter 1 (in the front end) but without beam dump even when the ID in operation. The pressure sensor G9 is for quick system. A vacuum valve combines with a fast close shutter (all in the front end) provide an interlock quick protection. When the pressure is higher than $\mathbf{5\times 10^{-4}}$Torr, the fast close shutter, valve and the beam dump system are triggered by the interlock system at the same time.

3. Pressure test in Commissioning

After cleaning, assembling, leak detection and optical collimating, the vacuum system starts its test. Some optical elements such as the mirrors, crystal cannot stand high temperature, so uniform baking temperature is very difficult to reach in the system, and non-uniform distribution is adopted in the baking process. The lowest temperature is 110℃ for optical equipments, and higher 150℃ for the others. Several pump stations consist of oil-free scroll pump and turbo-molecular pump are selected as roughing pump system. Ion pumps switched on after baking about 100 hours. Except rejection mirror(G10), every parts of the beamline obtain their satisfy pressure especially after operation one year. Table 1 gives the pressure at XAFS beamline in several cases.

Table1- Pressure at XAFS beamline (unit: Torr)

Date/ beam current	G1	G2	G3	G4	G5	G6	G7	G8	G10
2008-09/0mA	5.8×10^{-10}	1.3×10^{-9}	7.6×10^{-10}	5.9×10^{-9}	2.6×10^{-8}	1.1×10^{-9}	7.4×10^{-10}	8.5×10^{-10}	7.7×10^{-8}
2010-02/0mA	3.3×10^{-10}	1.2×10^{-9}	2.9×10^{-10}	1.5×10^{-9}	2.0×10^{-7}	7.7×10^{-10}	-	-	5.6×10^{-9}
2010-03/200mA	1.1×10^{-9}	4.2×10^{-9}	3.9×10^{-9}	8.3×10^{-8}	2.2×10^{-7}	1.5×10^{-9}	-	-	6.4×10^{-9}

4. Conclusion

A high performance XAFS beamline (BL14W1) is open to the users now. Its vacuum system was successful in the design, test and operation. We are now considering its improvement, such as the ion pump switches off while the liquid nitrogen system of DCM warms up, and some UHV valve positions are not so reasonable as we hope.